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THE USE OF THE ANTENNÆ IN INSECTS.

BY L. TROUVELOT.

IT has been a question among naturalists whether the antennæ of insects were organs of touch, hearing, or smell. Notwithstanding the progress of science, our knowledge of this subject does not seem to have much advanced. While some naturalists, such as Blainville and Latreille, place the sense of smell in the antennæ, others, such as Hentz, Baster, Lehrmann, Dumeril, and Cuvier, refer it to the spiracles, Huber to the mouth, and Humboldt to different parts of the body. In a recent publication I see it stated that the antennæ are a great deal more complex than formerly supposed, and probably unite the functions of touch, hearing, and taste.

In view of this great divergence of opinion it occurred to me many years ago that experimentation would throw some light upon this subject, and I therefore began a series of experiments which I will here record.

I procured fifty or sixty living butterflies of *Limenitis Disippus* Godt. I had seen it stated that "Dr. Clemens having deprived butterflies of their antennæ, and having thrown them up, had observed that they could not fly, and fell heavily down without opening their wings." 1. I first repeated this experiment with about a dozen individuals, all of whom, without exception, took flight, but I could observe a certain hesitation in the flight which gave less boldness and accuracy to their movements.

2. I then prepared some very thick Indian ink, and with a brush I covered carefully the eyes of several individuals, and waited until the opaque body was perfectly dried before experimenting. I let one and then another go free; they could fly, and strange as it might seem, though perfectly blind, in no case did one go blindly and hurt itself by flying against anything hard, but on the contrary they seemed to have a knowledge of the proximity of these objects, and in some cases would turn away and rest upon

some other thing. But it was noticeable that before resting, the insect acted exactly the same as uninjured individuals out-of-doors, by moving its wings, poising itself for a moment in the air in front of the object on which it had chosen to rest. A proof that the insect was perfectly blind and could not see is the fact that none of those which had their eyes covered with Indian ink were observed to fly to the single window giving light to the room where the experiments were made; if they had seen but slightly, they would have flown to the light, as all insects do in similar cases.

3. With one of these insects deprived of light I made, with a pair of scissors, and close to the head, a section of both antennæ. This insect when thrown up fell heavily down, sometimes not opening its wings at all, and was entirely unable to direct its flight.

4. I made another butterfly blind, and removed the antennæ, as in Experiment 3, and placed it at liberty upon a table, allowing it to rest a few minutes. I prepared a solution of sugar and water, and with a small brush I took up a drop of the sweet liquid, and then slowly and carefully I moved the brush very near the mouth, the head, and the spiracles, in fact all around the body. The poor blind butterfly remained perfectly still; no emanations whatever seemed to reach it from so sweet a substance. Then, guided by induction, I touched the stumps of the cut antennæ; no sooner was this done than it received the impression, unrolled its proboscis, and with great activity searched for the sweet object, in order to realize the impression it had received. For two or three minutes it was actively employed in the search, when I put before it a drop of the sweet beverage which it soon found and drank.

5. Taking another butterfly, prepared like the above, I placed on each stump of the antennæ a very small drop of thick gum arabic, and waited until it dried. This insect, thus prepared, when thrown up seemed to be without sensation, falling down like a stone, without any motion of the wings. As with the preceding butterfly, I placed it upon a table, and held the brush with the drop of sugar-water and let it touch the sealed antennal stump, but no impression was received. I also pressed the brush on the proboscis, but it was not until I had pressed so hard as to wet it through that it felt the impression and unrolled its tongue.

The following summer I made some fresh experiments upon this interesting subject. Of all the Lepidoptera with which I

am familiar in this country, the *Promethea* silk-worm moth is the one which in confinement will most readily accomplish the act of copulation. I have not yet found that a virgin pair on being put together did not unite the following afternoon.

6. I took several virgin pairs of this species (*Callosamia Promethea*), put each pair in a separate box, and let them remain together until they died. Each male had been deprived of its antennæ. I collected the eggs carefully; without an exception they were unfertilized, sexual union not having taken place.

Since making these experiments, it occurred to my mind that it might be objected that by cutting off the antennæ of an insect the pain resulting from such a wound would sufficiently explain the failure of a congress of the sexes. I have many times observed the sexual union of insects with one or two legs wanting, with wings half broken, etc. So, last summer, in order to test the value of this objection, I procured a certain number of virgin *Promethea* just out of the cocoon, and mutilated the males in different ways, some by cutting off a piece of the wings, others by the removal of a leg. These mutilated males were put with the virgin females, but notwithstanding their wounds union took place, and I raised young worms from the eggs laid by the females.

7. One afternoon I was sitting upon a rock under the shade of a tree, when my attention was attracted to a procession of a large species of ant, going from the nest to a considerable distance to gather, I think, some article of food. I contemplated in silence for some time the efforts of these industrious little laborers, when an idea crossed my mind that I had an opportunity to make one more experiment upon the use of the antennæ. I caught two or three of them, and with a small pair of scissors cut off the antennæ, and then I let them go free by the side of their busy comrades. But it was of no use; they did not seem to recognize their brothers, and did not follow the same path, but would trace a circle and turn about in every direction as if to find the route they were following before, not seeing that they had crossed it hundreds of times, and that their friends were following that same route; their eyesight was not sufficient to enable them to discover their way. After observing them for more than an hour, I found that they had not gone out of this circle when I left them.

From the second experiment I infer that when deprived of sight, insects fly with less boldness and accuracy, but they do not

blindly fly against objects, being apparently aware of their proximity. Here the faculty of sight is only an adjunct to the sense which resides in the antennæ.

In insects subjected to the first experiment, though having the power of sight, flight is deficient, the antennal sense is wanting to help the sight, and when the eyes and antennæ are rendered useless the insect is totally unable to direct its flight or to find its food. The compound eyes of insects do not seem to enable the insect to see objects at a distance, so vision is aided by another sense which has the antennæ as its organ.

In the sixth experiment the male *Promethea* had his sight; he could see near him another insect like himself, but his eyes alone could not tell him whether the insect was of the same species and of another sex, so he died near the object he would have desired with so much ardor if the sense organs which would have enabled him to detect the presence of the object had not been removed. So it was in the seventh experiment; the ant could see the others going on their way so intelligently, but with its eyes alone it could not recognize its friends; all were mute to him, and in the midst of friends he seemed to be in a desert.

Were I to draw any conclusion from these experiments I would say that the sense localized in the antennæ cannot be regarded only as that of touch, hearing, or taste, nor can it be regarded as uniting their complex functions. In no case have I observed insects using the antennæ as feelers; it is true they move them very rapidly when they want to recognize an object, but very seldom do the antennæ come in contact with the object; if they are feelers, they feel at a distance. With more reason they should be regarded as organs of smell, but if their functions have some analogy with the sense of smell, I think they must be very different from the sense of smell in the human species, and I would venture to say that it might have some analogy with the sense so little known though so common among animals, — with the horse, for instance, — which enables it if removed not to retrace, but find a straight line to its home, from a considerable distance, and with as much accuracy as if it could see it. So in my opinion this sense, being different from the senses common to the human species, needs a new name so as to be distinguished from and not confounded with the sense of smell. It is a kind of feeling or smelling at a great distance, by some process now totally unknown.